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THE AMERICAN NATURALIST.

VOL. XXXIX.

February, 1905.

No. 458.

THE BONES OF THE REPTILIAN LOWER JAW.

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As is well known, the lower jaw in the Reptilia consists of a number of bones to which, eighty years ago, Cuvier gave names, repeating the descriptions with slight alterations in the second edition of his work on fossil bones (1836). He described the elements in the jaw of crocodiles, tortoises, lizards, and snakes, in the order named. Since his day different anatomists have altered these names for various reasons or have applied them to different bones from those to which they were originally given. It has recently become necessary, in connection with some investigations, to revise the nomenclature of these elements, the results of which are given below. Williston has recently pointed out the necessity of some changes.

Cuvier recognized, at most, six bones to which he gave the names articulaire, surangulaire, angulaire, complémentaire or coronoidien,¹ operculaire, and dentaire. These were given English forms by Owen, who changed the names of two. The operculaire he renamed the splenial so as to avoid confusion with

¹ He refers to an earlier work by Adrien Camper (*Ann. Mus. Nat. Hist., Paris*, xix, 1812) for a previous use of the term coronoidien, but Camper merely refers to the parts as the *apophyses coronoides*.

the operculum of fishes, while for the complementaire he adopted the alternative coronoid because of its resemblance to the earlier named coronoid process of the mammalian jaw. Other names have been changed by other authors.¹ Thus Wagner calls the articulare the *pars angularis*, the dentary the *pars alveolaris*, the angulare the *p. complementaris posterior*, the splenial the *p. comp. anterior*, and the surangular the *p. comp. exterior*, while Brühl calls the splenial the marginale; the surangular and the coronoid, the ecto- and endo-complementaire. Baur (*Anat. Anz.*, xi, 1896) has attempted to homologize these bones in different reptiles, but it would seem that he has fallen into one or two errors, by taking the turtle rather than the crocodile or the lizard as his basis. As will be seen below there is practical unison in the use of terms by Cuvier in both crocodile and lizard while the turtle exhibits some differences, and again, to use the turtle as the basis would introduce no little confusion into the literature. So I have adopted the lizard as the basis of my work.

Practically all authors are agreed upon two of the elements, the dentary and the articulare, the first forming the anterior bone of the lower jaw, the latter being developed by ossification in the posterior part of Meckel's cartilage and forming a bone by which the lower jaw is articulated with the quadrate.

In an embryo of the lizard *Sceloporus* in which the centers of ossification have appeared, reconstruction from serial sections shows the following elements (Fig. 1). Meckel's cartilage (*m*) is a long, slender, slightly curved cylindrical rod, the cartilages of the two sides being continuous at the symphysis of the jaw. Just in front of the articulation with the quadrate, a strong dorsal process marks the anterior boundary of the articular facet (*a*), the cartilage extending a short distance behind this point.

The most posterior ossification is a long and slender bone (*da*) which extends backwards nearly to the posterior end of the meckelian. Behind, it lies on the lower inner surface of the cartilage, but farther forward it rises on the inner surface.

¹ No attempt has been made to find all the terms employed, or to trace each to its earliest use.

Later this element fuses with the bone ossifying in the posterior end of the meckelian, thus forming a part of the articulare, which, as is well known, consists of both cartilage and dermal constituents in the Lacertilia. For this dermal element, which in some reptiles is distinct throughout life, I have adopted the term *dermarticulare*.¹ Its characteristics are its position on the posterior inner side of Meckel's cartilage, its inferior margin being overlapped by the angulare and its anterior end, which lies ventral to the coronoid, by the splenial element next to be described.

The angulare (*an*) lies on the ventral surface of Meckel's cartilage, its posterior end reaching to about the middle of the *dermarticulare*, the lower margin of which it overlaps. The splenial (*s*) lies on the inner surface of the meckelian, its posterior end overlapping the anterior end of the *dermarticulare*. The coronoid (*c*), which lies on the inner side of the jaw dorsal to the splenial and the anterior end of the *dermarticulare*, needs little description.

On the outer side of the jaw are the dentary and the surangular bones. The dentary (*d*) occupies the anterior two thirds of the jaw, bending below the meckelian so as to be visible beneath it from the inner side, while above, it makes a broad in-curved and down-curved plate, the future alveolar surface. The surangular (*sa*) lies in the posterior third of the jaw, extending backwards behind the articulation but not quite to the posterior end of the meckelian, while below it hardly reaches the ventral border. Its upper margin arches in a broad curve above the meckelian from which it is separated by a large space.

The changes involved in the future development are extensions of all the bones so that the meckelian is covered on both inner and outer surfaces and in the coössification of articulare and *dermarticulare* to a single element (Figs. 2, 2a). It will be seen that these parts agree in names and positions with those described by Cuvier. The only difference between his account and that given here is the recognition of the *dermarticulare* as a

¹ This term has been used in the ganoids by van Wijhe. In some instances the element he has so called is clearly homologous with the *dermarticulare* of the reptiles but in others (*Amia*) it is a different form.

distinct element, the existence of which has been noted, although no name has been given it, by later writers. The problem is to homologize these elements with those found in the lower jaw of other reptiles, in some of which Baur believed that he had discovered a distinct bone which he has called the presplenial.

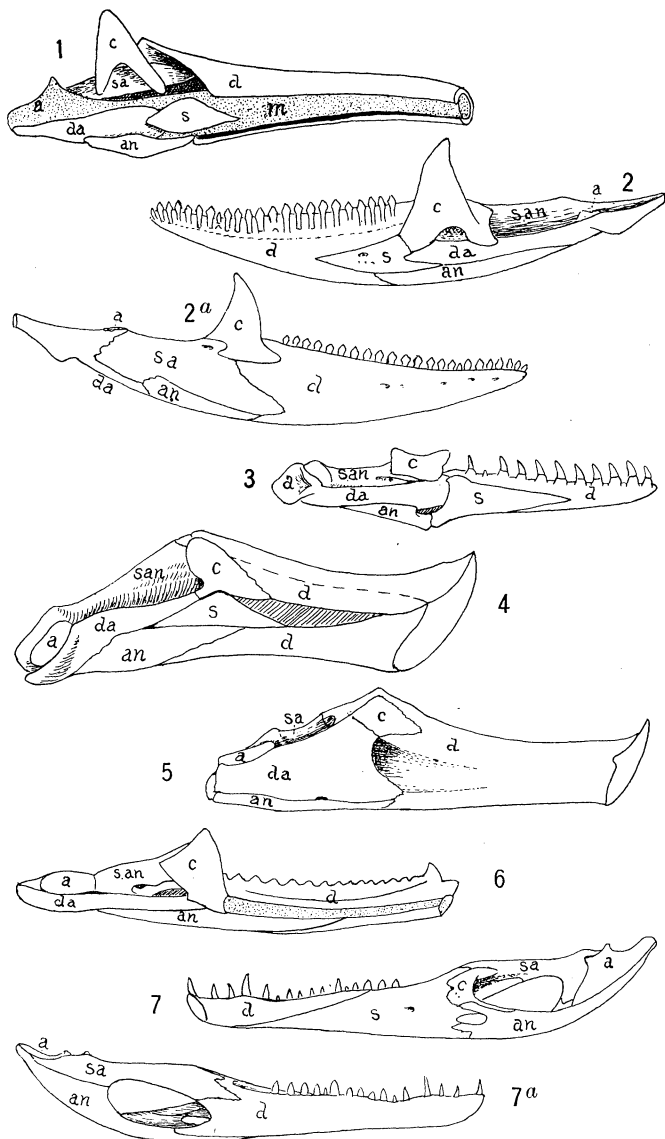
In the mosasaurs (Fig. 3) the matter is simple. Here derm-articular (*da*) and articular (*a*) have united into a single bone, the anterior splint of which occupies exactly the position,—below the jaw behind, rising to its inner surface in front,—that the dermarticulare does in the *Sceloporus* embryo. The splenial (*s*) is greatly enlarged and extends far forward on the inner surface. The other bones call for no comment, except that the surangular (*s. an*) bends inwards over the meckelian in the way described for the lizard.

Baur begins his account with a description of the turtle *Emydura* (Fig. 4) in which he recognizes his presplenial, but I am compelled to think that here he has fallen into error. On the inner side of the articular (*a*) is a long splint-like bone which passes forward and upward on the inner side of the jaw (*da*). This Baur interprets as the angular. In its position it clearly corresponds to the dermarticulare which has failed to fuse with the articulare proper. Below this is a bone as evidently the angular (*an*) but which Baur is compelled to call the splenial. Hence, according to him, the true splenial (*s*) which occupies the same position as in the lizard, is an additional element, the presplenial. Baur's mistake¹ thus had its foundation in his identification of the dermarticulare as the angular although he expressly recognizes the fact that in the *Lacertilia* the articulare is composed of chondrogenous and dermal elements.

In the ordinary turtles, of which the snapping turtle (*Chelydra*) may be taken as an example (Fig. 5), the splenial is lacking, the angular (*an*) extends back to near the posterior end of the jaw, while the dermarticulare (*da*) forms a very large plate on the inner surface, reaching forward to just beneath the coronoid process (*c*).

Baur has also described and figured the jaw in *Sphenodon*

¹ Baur merely repeats the wrong identification of Cuvier.

FIG. 1.—Reconstruction of elements in the jaw of an embryo *Sceloporus*, cartilage dotted.FIGS. 2, 2a.—Inner and outer surfaces of jaw of *Iguana tuberculata*, after Blanchard.FIG. 3.—Jaw of *Platycarpus coryphaeus*, after Williston.FIG. 4.—Jaw of *Emydura*, after Baur.FIG. 5.—Jaw of *Chelydra serpentina*.FIG. 6.—Jaw of *Sphenodon*, after Baur.FIGS. 7, 7a.—Jaw of *Alligator lucius*, inner and outer surfaces.

a, Articular; an, Angular; c, Coronoid; d, Dentary; da, Dermarticular; m, Meckel's cartilage; s, Splenial; sa, s. an, Surangulare.

(Fig. 6), and his identifications are adopted by Howes and Swinnerton. Yet it seems probable that here again the dermarticulare (*da*) has been termed the angulare and the angulare (*an*) the splenial. Judging by Günther's figures, which do not agree with that of Baur, it is possible that the angulare is an angulo-splenial as he suggests, but the observations of Howes and Swinnerton show no separate elements. The articulare cannot be a compound structure like that in the Lacertilia, for, in the development no dermarticulare, other than that interpreted as such here, occurs.

In the case of the alligator (Fig. 7) I feel less certain. As is well known, besides the articulare (*a*), three bones form the inner surface of the jaw, a bit of the dentary (*d*) being visible near the tip. There can be no question about the coronary (*c*) while the large plate extending forward from the coronoid (*s*) is as clearly the splenial, if the conclusions regarding the other forms studied be correct. The remaining element (*an*) is the more problematical. Baur calls it the splenial and thinks that the angulare is fused with the articulare. It is clearly not the splenial, but it exhibits characteristics of both angulare and dermarticulare, being like the dermarticulare in its articulation with the coronoid, but like the angulare in the rest of its extent. There is no separate bone on the inner side of the articulare and there is a large gap in front of the articulare, extending to the coronoid, which in all other forms is occupied by the dermarticulare. Hence until a study of the development shows that this conclusion is untenable I prefer to call it the angulare and to assume that the dermarticulare has failed to develop. It is the angulare of Cuvier.

These comparisons need to be continued into the Ichthyopsida and especially into the Stegocephala and the ganoids where considerable confusion exists.